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Symbolics and Apple computer systems to enhance neural network modeling research were provided under this Defense University Instrumentation Program grant.

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Final Technical Report
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Due 31 May 1988

Equipment Actually Acquired

AFOSR-TR- 88-0921

From Symbolics, Inc.:

1	Symbolics 3650 Symbolic processing workstation, including: 3650 base unit with single 368 MB disk	$39,950
1	PE36-CONS monochrome console	$6,800
1	MEM2-1 2 MWord memory	$10,965
1	OP36-TC4FScartridge tape drive	$3,285
1	STCP-1 TCP/IP networking software	$3,000
1	LGP2-SW Software interface for Apple LaserWriter	(no charge)
	Shipping:	$449

From Apple Computer, Inc.:

1	LaserWriter Plus Printer	$3,608
1	Macintosh II CPU	$2,099
1	A/UX External 80MB drive and memory management (part of $2,587 A/UX bundle)	$2,209

Changes to Equipment List

The equipment actually acquired agrees closely with the equipment specified in the grant. Two changes are noted below:

- A 3650 workstation replaces the discontinued 3640 originally specified.

- A substitution, approved by the Contracting Officer, replaced the FORTRAN toolkit originally specifed, which consisted solely of software and which was budgeted at $2,800. Instead, a UNIX system (A/UX) was acquired, consisting not only of a FORTRAN compiler and appropriate toolkit, but also a UNIX processor with hardware floating point processor and networking software to the symbolic workstation. The approximately $1,500 greater cost of the UNIX system was accommodated by a retroactive reduction in the price of the LaserWriter printer, as well as a late-negotiated discount from Symbolics, Inc.

Summary of Research Projects:

General: The Symbolics hardware has been operational for some time, but appropriate software is still under development. There have been three revisions of system software since the grant proposal was written. Furthermore, object-oriented programming is to be used for at least one major project, and this was begun using the currently most advanced system, Flavors. However, Flavors is scheduled to be superseded in the near future by a newer Common Lisp object-oriented programming system, and the project has been delayed until this software is released to researchers.

Also anticipated for the future is the installation of the Symbolics as a directly addressable node on the Internet, permitting access to and from ARPAnet and other networks.

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Research projects which are using or will use the equipment acquired under this grant are generally as specified in the original proposal. These include:

Modeling - Daniel Gardner, Ph.D., Principal Investigator: A major goal of this ONR- and AFOSR-funded project is the development of functional rather than operational models of nervous systems. Many present models ignore physiological mechanisms and diversity, while others, formally comprehensive, exhaust mid-range computers to model single cells. Under development is a model in which operational details are properties local to individual cells, while the input-output behavior of neurons is described by functional consequences. Object-oriented programming is used, in which neurons and the information they utilize can inherit and mix properties on each of several levels. As indicated above, modeling has begun, but further development is deferred pending new software. In the interim, additional software platforms for modelling have been acquired and loaded onto the Symbolics; these include P3 for neural networks and QSIM for qualitative simulation. The overall aim of these studies is an understanding of the contributions both of complex synaptic input and also of network connectivity to the function, adaptiveness, and organization of nervous systems. Computational and artificial intelligence techniques will be applied to data obtained from neurons of invertebrate ganglia in order to model the function of neural networks.

Membrane Biophysics - Olaf S. Andersen, M.D., Principal Investigator: The long-term goal of this NIH-funded research is the understanding of molecular characteristics of ion movement through transmembrane channels. This goal is pursued through studies on low-molecular channel formers: the linear gramicidins whose structural information is available, and through studies on macromolecular channels: the voltage-dependent sodium channels.

Although this work is primarily computational, the availability of the combined Symbolics/Apple system, with its large virtual address space and capability for symbolic as well as floating-point numerical manipulation, will permit a variety of extended modelling studies on channel behavior which would not be possible otherwise, allowing insight into: 1) the steps involved in ion entry, 2) structure-function relations, and 3) modulation of channel behavior by interfacial dipole potential.

Mathematics of Biological Systems - John L. Stephenson, M.D., P.I.: A major aim of this multipart NIH-funded project is the development of a mathematical model of electrolyte transport in the whole kidney, including electrolytes, glucose, urea, protein oncotic forces, hydrostatic pressure, and electrical potential. As a first step, equations have been derived and an electrolyte model of the renal medulla programmed that includes Na, K, Cl, urea, an inpermeant, hydrostatic pressure, and electric potential. The solutions of the large system of equations this model requires, mandates the inversion of very large matrices, a process which is computationally very time consuming and requires a large amount of RAM storage. Analytic methods can significantly decrease this computational time and storage. The symbolic processing capabilities of the Symbolics, coupled with MACSYMA software to generate code and provide partial analytic solutions will significantly increase the capabilities and applicability of this modelling scheme.

Daniel Gardner, Ph.D.,
Principal Investigator